THE UNIVERSITY OF HONG KONG

DEPARTMENT OF MECHANICAL ENGINEERING

SEMINAR

Title: **Electrochemical devices across length-scales: From electrodes to battery packs/ fuel cell stacks**

Speaker: **Dr. Billy Wu**
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Date: **17 September, 2019 (Tuesday)**

Time: **10:30 a.m.**

Venue: **Room 7-37, Haking Wong Building, HKU**

Abstract:
The ability to be able to characterise and predict the performance of electrochemical devices at the electrode, cell and pack/stack level is essential for the design of systems with higher energy and power densities. This talk will present findings on how in-situ and ex-situ x-ray computed tomography can be used to understand microstructural features which define the performance and lifetime in high energy density battery systems and hydrogen fuel cells. This includes in-situ synchrotron studies of zinc dendrite formation and dissolution and lab-source based studies of electrode-current collector delamination in silicon based anodes. Insights into these microstructural features then enables researchers to design electrodes which improved transport properties which suppress degradation effects. Examples covered will include the effect of freeze-alignment to create separators with aligned pores and the use of electrospun electrodes to encapsulate tin based particles to contain active material fracture and thus capacity fade. Further insights into novel manufacturing routes to create hierarchical electrospun nanofibers, with a facile synthesis of catalytic and carbon nano-hair domains, will be presented along with examples of how this novel electrode

microstructure improves the electrochemical performance of zinc-air based batteries.

At the cell and pack level, characterisation and prediction techniques are equally as important in-order to design and control practical systems. Here, work on the effect of thermal gradients on lithium-ion battery pouch cells will be presented as well as combined continuum level modelling efforts to predict how uneven thermal gradients and contact resistances in packs can lead to heterogeneous current distributions and uneven degradation in highly parallel battery packs. Efforts on how mechanical effects such as predicting particle stresses and fracture in electrodes at high C-rates will also be explored, as this can lead to accelerated failure due to particle fracture and the enhanced growth of the solid-electrolyte interphase layer.

For fuel cells, work will be presented on microstructural characterisation of novel fibre-based electrodes for solid-solid fuel cells, a novel nature inspired 3D printed fractal based proton exchange membrane fuel cell flow field and passive supercapacitor hybridisation of a 9 kW fuel cell system.

Finally an overview of the UK's £246M Faraday Institution will be presented which has the aim of stimulating fundamental, translational and scale-up activities in lithium-ion batteries. Here the 4 fast start projects include: multi-scale modelling, degradation, recycling and solid-state batteries.

About the speaker:
Dr. Billy Wu co-leads the Electrochemical Science and Engineering group in the Dyson School of Design Engineering at Imperial College London. His research activities include: energy storage/conversion technologies (lithium-ion batteries, redox flow cells, supercapacitors and fuel cells) and manufacturing (3D printing, nanofibre electrospinning). He has published 35 peer reviewed journal papers, 2 book chapters and 4 patents since completing his PhD in 2014 and sits on the editorial board of Scientific Reports. He has been an investigator in research projects worth in excess of £46M, directly managing a budget of >£2M and is a co-investigator for the UK Faraday Institution battery research centre. He directly leads a team of 7 post-docs and 6 PhD students within the wider Electrochemical Science and Engineering group which has >50 researchers. Prior to his PhD in automotive proton exchange membrane fuel cell-lithium-ion battery hybrid systems, he completed his masters in Mechanical Engineering from Imperial College London in 2010.

ALL INTERESTED ARE WELCOME

For further information, please contact Prof. D.Y.C. Leung at 3917 7911.

Research area: Energy